

Review

Psychological benefits of exercise for cancer survivors

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Abstract: Cancer survivors often face a variety of psychological challenges during the treatment process. With the promotion of comprehensive treatment models, exercise, as a non-pharmacological adjunct therapy, has increasingly gained attention for its role in improving the psychological health of cancer survivors. This paper reviews the relevant literature and deeply explores the positive effects of exercise on the psychological health of cancer survivors, attempting to reveal the physiological and psychological mechanisms behind these effects. From a psychological perspective, exercise not only alleviates symptoms of anxiety, depression, and cancer-related fatigue but also fosters positive social interaction and enhances self-efficacy. The realization of these positive effects may involve multiple mechanisms, such as increased levels of endorphins after exercise, increased cardiorespiratory and muscle strength, enhanced immune system functioning, increased social support, and improved self-efficacy. This paper also analyzes the main challenges encountered in the implementation of exercise interventions, such as individual differences among patients, exercise compliance, and how to more effectively integrate exercise interventions into standard cancer treatment. Finally, this paper looks forward to the direction of future research, suggesting that subsequent studies should focus on the personalized design of exercise interventions, explore the specific effects of different types, intensities, and durations of exercise on cancer survivors of different types and stages. Demographic characteristics such as cultural background, socioeconomic status, gender, and age should also be explored in depth to explore the potential moderating effects of exercise intervention effects and adherence. Collectively, these findings highlight the novel psychosocial contributions of exercise interventions, particularly in facilitating social interaction and enhancing self-efficacy, thereby offering a more comprehensive understanding of their therapeutic potential. This is expected to provide a more scientific and effective exercise intervention strategy for the quality of life and psychosocial resilience of cancer survivors.

Keywords: cancer survivors; psychosocial resilience; quality of life; psychological support; exercise intervention; anxiety; depression

1. Introduction

Cancer stands as a principal public health challenge on a global scale, severely impacting not only the physical health of patients but also profoundly affecting their psychological state. Traditionally, cancer treatment has primarily relied on methods such as surgery, chemotherapy, and radiotherapy. However, these therapeutic approaches, while effective in eradicating cancer cells, often come with a host of side effects, including physical weakness, a decline in immune function, and a variety of psychological issues, such as anxiety, depression, and a reduction in self-worth. With the shift in medical paradigms and the renewal of health concepts, enhancing the quality of life of cancer survivors and promoting their psychological recovery has become an integral part of modern cancer treatment [1–4]. In recent years, exercise,

as a non-pharmacological adjunctive intervention, has increasingly been recognized for its positive role in the cancer rehabilitation process, supported by scientific research. Studies indicate that moderate exercise can not only improve the physical condition of cancer survivors, such as by enhancing muscle strength and cardiovascular function, but also aid in alleviating side effects of treatment, such as nausea, fatigue, and cognitive impairments [5–8]. More importantly, exercise has demonstrated unique effects on easing psychological stress, and strengthening social interaction capabilities of cancer survivors [9–11]. Despite the preliminary understanding provided by existing research on the impact of exercise on the psychological health of cancer survivors, many unknowns and controversies remain. For instance, what types, intensities, and durations of exercise are most beneficial for patients with specific types of cancer? What is the optimal timing for exercise intervention? How to assess exercise compliance and effectiveness? Moreover, the specific biological and psychological mechanisms by which exercise improves the psychological health of cancer survivors are not yet fully understood [12]. This paper aims to explore the impact of exercise on the psychological health of cancer survivors and attempt to reveal the physiological and psychological mechanisms behind it, through literature review and analysis. Furthermore, we will discuss the challenges and strategies in the implementation process of exercise interventions, providing a scientific basis and operational recommendations for clinical practice. Through the exposition of this paper, we anticipate offering new perspectives and practical pathways for the comprehensive treatment and rehabilitation of cancer survivors.

2. Literature search methodology

All literature was retrieved from the electronic database PubMed. The search timeframe encompassed studies published from January 2000 to December 2024. The main keyword combinations included: (“cancer survivors” OR “oncology patients”) AND (“exercise” OR “physical activity” OR “aerobic training” OR “resistance training” OR “combined training”) AND (“psychological well-being” OR “mental health” OR “quality of life” OR “anxiety” OR “depression” OR “fatigue”)

The literature selection process consisted of two phases. First, a preliminary screening was performed based on titles and abstracts, excluding studies clearly unrelated to the topic. Second, a full-text review was conducted of potentially eligible literature to determine final inclusion. The number of included studies operations was the initial search yielding 634 records. After the duplicates are removed, filter the 310 records based on the title and summary. Then exclude some non-compliant records from the 251 records that meet the qualifications. 109 records were selected for full-text review, and finally, 109 studies met the inclusion criteria and were included in this review (**Figure 1**). Inclusion criteria were as follows: (1) Participants were cancer survivors (any cancer type and stage); (2) The intervention involved any form of physical exercise; (3) Studies reported outcomes related to mental health or quality of life; (4) Study types included randomized controlled trials (RCTs), clinical trials, or high-quality observational studies; (5) The language of publication was English. Non-English studies were excluded due primarily to language barriers and limitations in translation resources, ensuring the accuracy and consistency of data extraction and

synthesis. Exclusion criteria included: (1) Case reports, editorials, conference abstracts, or unpublished data; (2) Studies that did not provide specific exercise intervention programs or psychological outcome data; (3) Studies focused on pharmacotherapy or other non-exercise interventions.

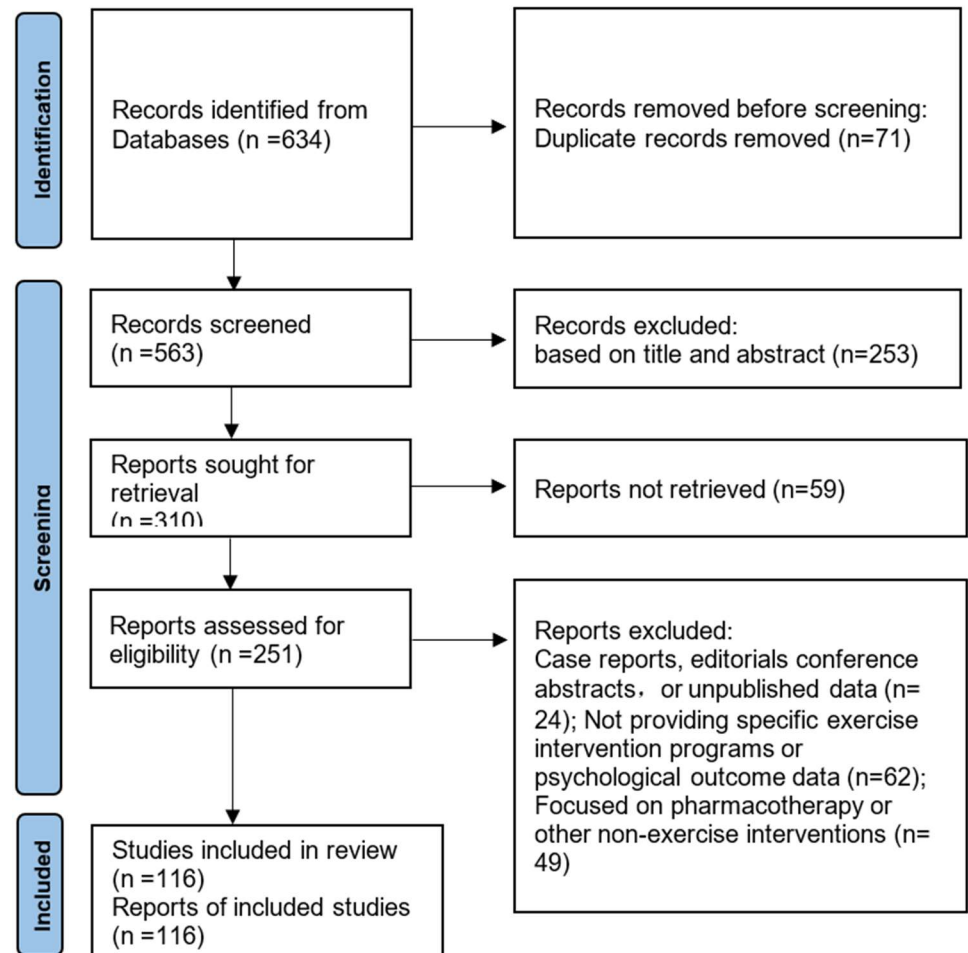


Figure 1. Flow diagram for selection of studies.

3. Psychological benefits of exercise for cancer survivors

Exercise has been shown to benefit the psychological health of cancer survivors across multiple dimensions, including reducing fatigue, alleviating symptoms of anxiety and depression, and enhancing overall well-being [2,3]. A multitude of studies have been conducted on exercise interventions for cancer survivors, employing a variety of exercise modalities, such as aerobic exercise, resistance training, dragon boat racing, recreational sports, rock climbing, triathlon participation, and high-intensity interval training (HIIT). The American College of Sports Medicine recently convened a team of clinical and research experts in the field of cancer and exercise to comprehensively evaluate the published research findings in this area [3]. The synthesis of these studies indicates that the exercise modalities with the clearest benefits for psychological health in cancer survivors are aerobic exercise and resistance training. Furthermore, a combination of aerobic exercise and resistance training appears to yield even more pronounced effects [3]. Other forms of exercise have not yet been adequately

supported by evidence for their safety and efficacy. Additionally, there is no evidence suggesting that these alternative forms are more effective than aerobic exercise and resistance training [3]. Specific impacts of aerobic exercise, resistance training, and their combination on the psychological health of cancer survivors are detailed in **Table 1**.

Table 1. Physiological effects and psychological outcomes of exercise on the cancer survivors.

Exercise Types	Intensity	Duration (min) or Sets (reps)	Frequency (sessions per week)	Physiological effects	Psychological outcomes	References	Special considerations
Aerobic exercise	60–80% HRmax, 60–80% VO2max, RPE 13–15	30–60	3	Cardiorespiratory fitness↑, immune function↑, chronic inflammation↓, neuroendocrine regulation↑	Anxiety↓, depression ↓	[13–21]	Patients with osteoporosis or a history of hormone therapy ^a . Patients with peripheral neuropathy induced by chemotherapeutic agents ^b . Patients with lymphedema ^c . Patients currently receiving or who have previously undergone transplantation or immunotherapy ^d . Patients undergoing radiotherapy ^e . Individuals with severe anemia ^f . Patients with reduced platelet counts ^g . Patients with indwelling catheters ^h .
	65% HR, max45% VO2max, RPE 12	30	3	Cardiorespiratory fitness↑, immune function↑, chronic inflammation↓	Fatigue ↓, QoL ↑	[15,22–28]	
Resistance training	60–75% 1RM, RPE 12–15	2–3 sets 8–15 reps	2–3	Muscular mass & strength↑, immune function↑, bone mineral density↑	Fatigue↓, QoL ↑	[29–36]	
Combination of aerobic exercise and resistance training	60–80% HRmax, 60–80% VO2max, RPE 13–15	20–40	2–3	Cardiorespiratory fitness↑, immune function↑, chronic inflammation↓, neuroendocrine regulation↑, muscular mass & strength↑, immune function↑, bone mineral density ↑	Anxiety ↓, depression ↓, self-efficacy ↑	[16,20,37–42]	
	65–85% 1RM,	2 sets 8–12 reps	2–3				
	65% HRmax, 45% VO2max, RPE 12	30	3	Social support ↑, fatigue ↓, QoL ↑	[22,25,43–47]		
	60% 1RM, RPE 12	2 sets 12–15 reps	2				

Note: ↓, Indicates a decrease; ↑, indicates an increase; HRmax, maximum heart rate; VO₂max, maximal oxygen uptake; RPE, ratings of perceived exertion; QoL, quality of life; 1RM, one-repetition maximum. a. High-impact loading exercises and movements that involve excessive trunk flexion, extension, or twisting should be avoided. During resistance training, direct loading on the affected area should be minimized. b. Neuromuscular training and resistance training should be prioritized, and alternative aerobic exercises to walking or running should be considered (e.g., stationary cycling, aquatic aerobics) to reduce the risk of falls. c. Exercise should be initiated under professional supervision, with a gradual increase in the volume and intensity of movement for the swollen limb, and close monitoring of limb circumference changes before and after exercise. d. Home-based exercise is encouraged, and public fitness equipment should be used cautiously to prevent cross-infection. Patients' tolerance should be frequently monitored, and the exercise volume adjusted accordingly to avoid excessive training that could impact immune system regulation. e. Special attention should be given to assessing the range of motion around the joints in the radiation treatment area, with a focus on local flexibility training. Chlorine exposure should be avoided, such as swimming in pools, and skin and soft tissue changes in the radiated area should be monitored before and after exercise. f. General exercise programs should be avoided initially, with an emphasis on increasing daily living activities. For those with severe fatigue, static stretching can be a starting point. g. Careful observation of skin and mucosal bleeding before and after exercise is necessary. Severe thrombocytopenia is not a contraindication to activity unless combined with unstable clinical conditions. Bedridden patients and those with prolonged sitting or lying should be encouraged to engage in activities such as ambulation and daily living tasks. h. Resistance training should be avoided around the area of the catheter, and intense exercise involving the catheterized limb should be minimized. For non-implanted catheters, activities that could lead to cross-infection, such as swimming, should be avoided.

Aerobic exercise has been shown to significantly reduce anxiety and depressive symptoms, alleviate fatigue, and substantially improve the quality of life in cancer survivors. Resistance training significantly reduces fatigue in these patients. The combination of aerobic and resistance training not only significantly reduces anxiety and depressive symptoms, alleviates fatigue, but also demonstrates superior outcomes compared to either type of exercise performed alone [3]. It is evident that moderate exercise can markedly improve the emotional state of cancer survivors, reduce anxiety and depression. These improvements are not only due to physiological adaptations but also contribute to enhanced self-efficacy and opportunities for social engagement. While numerous studies have demonstrated the benefits of aerobic exercise, resistance training, and their combinations for cancer survivors' mental health and quality of life, it is essential to acknowledge methodological heterogeneity across these investigations. For instance, variations exist in exercise intervention protocols (type, intensity, frequency, duration), cancer types and stages, and patient baseline characteristics that may contribute to inconsistent outcomes. Some earlier studies were limited by small sample sizes or employed non-rigorous randomized controlled designs, potentially compromising conclusion reliability. Clinically, it should be noted that cancer survivors' physical capacity is frequently compromised due to treatment-related sequelae. Consequently, adherence to progressive overload principles is critical during exercise participation. Moreover, those with such conditions should not only undergo a comprehensive assessment of their physical fitness and functional status before initiating exercise but also pay close attention to specific considerations related to exercise safety (**Table 1**).

While the benefits of exercise are evident, it is crucial to acknowledge that the efficacy and adherence to these interventions can be significantly moderated by various demographic and sociocultural factors. For instance, cultural beliefs surrounding health and physical activity, socioeconomic status influencing access to resources (e.g., safe exercise environments, financial means for programs), and gender-specific roles or body image concerns can all impact participation and outcomes. Future research and clinical implementation should therefore consider these nuances to ensure equitable and effective exercise delivery across diverse cancer survivor populations.

4. Mechanisms of exercise on psychological health in cancer survivors

A cancer diagnosis and its treatment often have a profound impact on patients' psychological health and overall quality of life, including issues such as anxiety, depression, stress responses, a sense of social isolation, and cancer-related fatigue. Exercise, as a non-pharmacological intervention, can not only alleviate patients' anxiety and depression but also enhance their overall psychological health. **Figure 2** presents a conceptual model illustrating the various interconnected physiological and social-psychological pathways through which exercise improves psychological health in cancer survivors. The following sections will delve into how exercise can improve the psychological health in cancer survivors through various mechanisms, including neurochemical changes, enhanced physical fitness, strengthened immunity, promoted

social interaction, and increased self-efficacy. Beyond physiological adaptations, the profound psychological benefits of exercise are often mediated through critical social-psychological pathways, which are further elucidated by established behavioral theories.

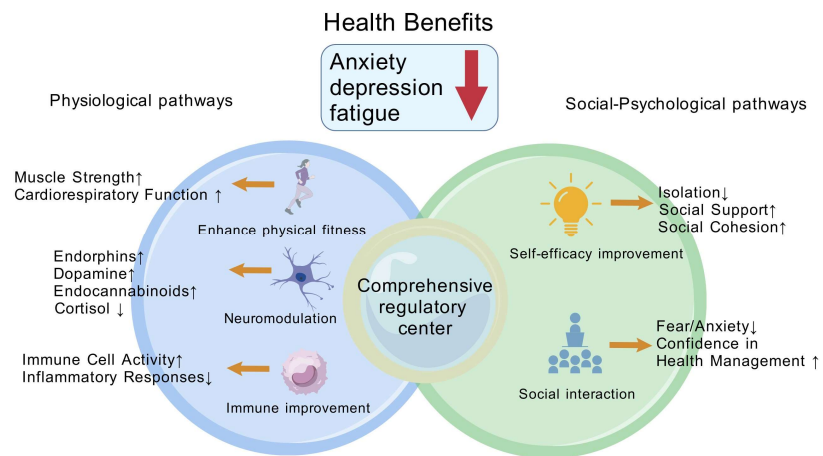


Figure 2. Conceptual model depicting pathways linking exercise to psychological outcomes.

4.1. Neurochemical changes

The diagnosis and treatment of cancer are often accompanied by significant psychological stress and stress responses, such as anxiety and depression. Exercise-induced neurochemical changes are one of the key mechanisms for improving mental health [48]. For example, exercise increases the release of endorphins, an endogenous opioid peptide, which binds to opioid receptors in the brain to produce analgesic and euphoric effects, which are effective in relieving anxiety and depression [49]. At the same time, exercise also upregulates levels of neurotransmitters such as dopamine, which play a central role in regulating motivation, reward, and mood, helping to enhance positive emotional experiences and the ability to cope with stress [50]. Similarly, endocannabinoids play a significant role in emotional regulation and pain perception [51,52]. Secondly, exercise can reduce the levels of stress hormones in the body, such as cortisol, thereby decreasing the patient's stress state [53,54]. Cortisol, as the primary hormone of the stress response, can lead to impaired immune function and exacerbation of psychological health issues when levels remain chronically high [55]. By reducing cortisol levels through exercise, patients can experience improved mood states, reduced anxiety, and less stress, thereby enhancing the psychological health. Additionally, exercise can also improve mood and enhance psychological resilience by promoting the release of neurotransmitters in the brain, such as dopamine and norepinephrine. These neurotransmitters enhance psychological resilience by increasing pleasure and motivation, helping to maintain positive emotions and improve decision-making abilities, making it easier to cope with stress and challenges [56].

4.2. Enhancing physical fitness to alleviate cancer-related fatigue

Cancer-related fatigue is one of the primary issues affecting the quality of life of cancer survivors. Multiple studies have shown that aerobic exercise, resistance training, and their combination can significantly alleviate cancer-related fatigue, improve their quality of life, and enhance physical function [2,3]. The enhancement of physical fitness, a core physiological pathway illustrated in **Figure 2**, significantly contributes to alleviating cancer-related fatigue [57]. The primary reason for this is that exercise can effectively improve the cardiopulmonary function and muscle strength and endurance of cancer survivors. Improved cardiorespiratory function and muscle strength not only alleviate physical fatigue but also enhance individuals' perceived physical competence and independence, contributing to a stronger sense of self-efficacy and a greater willingness to engage in social activities.

4.2.1. Improving cardiorespiratory function

Cardiorespiratory fitness, also known as aerobic endurance, refers to the capacity of the heart, blood vessels, and lungs to deliver oxygen and nutrients to various parts of the body. A decline in cardiopulmonary function is a primary cause of cancer-related fatigue. Enhancing cardiopulmonary function can effectively reduce the sense of fatigue in cancer survivors' daily lives. Evidence indicates that many cancer survivors experience a significant improvement in cardiopulmonary function following exercise training [58–60]. Aerobic exercise, resistance training, and their combination have all been shown to markedly increase cardiopulmonary function in cancer survivors. Specific improvements include indicators such as maximum oxygen uptake (VO_2max), cardiac output, vital capacity, respiratory muscle strength, and heart rate variability (HRV) [61–66].

4.2.2. Enhancing muscle strength and endurance

Cancer and its treatments often lead to muscle atrophy and physical decline in patients, which is another primary cause of cancer-related fatigue. Enhancing muscle strength and endurance is one of the effective ways to reduce the sense of fatigue in cancer survivors' daily lives. Studies have shown that resistance training has a significant impact on improving muscle strength and endurance in cancer survivors. While aerobic exercise primarily functions to increase cardiopulmonary fitness and endurance, it also has a positive effect on muscle strength in cancer survivors. Evidence indicates that resistance training significantly increased muscle strength and endurance in breast cancer, colorectal cancer, liver cancer, lymphoma, and prostate cancer survivors [3,67–69]. Aerobic exercise increased muscle strength and endurance in breast cancer, colorectal cancer, lung cancer, ovarian cancer, lymphoma, and prostate cancer survivors [27,70–72]. The combination of aerobic and resistance training has an even more pronounced effect on improving muscle strength and endurance in cancer survivors.

4.3. Enhancing immunity and reducing inflammatory responses

The immune system is a critical defense mechanism of the body against diseases. Studies have shown that moderate exercise can enhance immune function and reduce inflammatory responses in cancer survivors. This improvement boosts the body's

ability to combat infections and diseases, thereby enhancing psychological health and quality of life. The enhancement of immune function and the improvement of inflammatory responses have a significant impact on the emotional state of cancer survivors [66]. Aerobic exercise has been found to significantly increase the number and activity of immune cells in breast cancer and prostate cancer survivors, reduce the levels of inflammatory markers, and enhance immune responses [73–75]. Resistance training has significantly improved the quantity and activity of immune cells, such as NK cells and T cells, in breast cancer and colorectal cancer survivors, decreased levels of inflammatory markers, and enhanced immune function [76–79]. The combination of aerobic and resistance training has more significantly increased the number and activity of various immune cells, such as NK cells and T cells, in a variety of cancer survivors, showing lower levels of inflammatory markers and enhancing anti-cancer immune responses [80–83]. As shown in **Figure 2**, the improvement of immune function and reduction of inflammatory responses represent another crucial physiological pathway through which exercise benefits psychological health [84]. These physiological improvements can positively impact mood and energy levels, thereby reducing psychological distress and fostering a more positive outlook that facilitates social engagement.

4.4. Facilitating social interaction and enhancing self-efficacy

Cancer survivors often face the risk of disconnection from society, and participating in group exercise activities can promote their social interaction, reducing the sense of social isolation and loneliness [85,86]. By interacting with others and sharing experiences, patients can feel more supported and understood, which enhances self-efficacy and alleviates the psychological burden [87–90].

Social support is a crucial factor in the recovery process of cancer survivors. Beyond the physiological effects, exercise profoundly impacts psychological well-being through social-psychological pathways, specifically by facilitating social interaction and enhancing self-efficacy, as highlighted in **Figure 2** [91]. The positive impact of exercise on social interaction and self-efficacy can be comprehensively understood through the lens of behavioral theories, particularly the Social Cognitive Theory (SCT) [92]. SCT posits that human functioning is a result of the interaction between personal factors, environmental factors, and behavioral factors. In the context of exercise for cancer survivors, this theory highlights how mastery experiences, vicarious experiences, social persuasion, and physiological and affective states contribute to self-efficacy and sustained engagement. Studies have shown that engaging in exercise can significantly enhance the social support system of cancer survivors, improving their mental and emotional health. Aerobic exercise, resistance training, and the combination of both have shown beneficial effects on social support. Breast cancer survivors, for example, have enhanced family connections and support through aerobic exercise, improving the quality of family relationships, promoting communication with family members, increasing emotional support and understanding, and gaining more social support, enhancing their social support networks [93–95]. Breast cancer survivors participating in resistance training programs have established deep friendships and support networks, feeling the power

and support of the group, not only strengthening their connection to the community but also improving communication and support within the family, helping cancer survivors to adhere to exercise routines [96,97]. The combination of aerobic and resistance training has allowed cancer survivors to feel supported and encouraged by one another, creating a positive and uplifting team atmosphere, integrating them into society, and enhancing confidence and self-esteem [98,99]. It is clear that engaging in exercise can significantly strengthen the social support system of cancer survivors, improving their mental and emotional health.

Additionally, cancer survivors often feel helpless and out of control when faced with the diagnosis and treatment of the disease, which can have negative effects on their mental health. Regular exercise can not only improve physical health but also significantly increase a patient's sense of self-efficacy. Self-efficacy refers to an individual's confidence and belief in their ability to control situations when faced with challenges [100]. Through exercise, patients can experience improvements in both their physical and mental states, enhancing their confidence in controlling their own health [101,102]. This increased self-efficacy is particularly important for the psychological recovery of cancer survivors as it can reduce feelings of fear and anxiety and enhance their positivity and adaptability to treatment [103].

5. Future perspectives

As the role of exercise in cancer rehabilitation becomes increasingly prominent, future research faces numerous challenges and opportunities. This section will delve into these future research directions, aiming to provide more precise and personalized recommendations for the clinical application of exercise.

5.1. Individualized exercise intervention programs

Future research should be directed to develop more precise individualized exercise intervention programs. This requires consideration not only of cancer type, stage, treatment regimen, and the patient's physical and psychological condition, but also of biomarkers (e.g., gene polymorphisms, inflammatory factor levels, BDNF levels) monitoring to dynamically adjust exercise prescribing. The use of artificial intelligence and machine learning algorithms to analyze big data is expected to identify the key individual factors that affect the effectiveness of exercise, so as to tailor the optimal exercise recommendations for each cancer survivor to maximize intervention effectiveness and compliance [104,105].

5.2. Timing of exercise interventions

At different stages of cancer treatment, patients' physical conditions and psychological needs vary significantly. For instance, during chemotherapy, patients may be temporarily unable to engage in high intensity exercise due to side effects; whereas in the recovery phase, moderate exercise may greatly enhance the restoration of physical functions [87]. Therefore, exploring the optimal timing of exercise interventions and how to coordinate with mainstream treatment methods (such as surgery, chemotherapy, and radiotherapy) will be of great significance in improving the effectiveness of exercise interventions [37]. Future research should employ

rigorous study designs, such as Randomized Controlled Trials (RCTs), to systematically investigate optimal timing. For example, RCTs could compare the efficacy of exercise interventions initiated prior to chemotherapy versus those initiated during or after chemotherapy on specific psychological and physiological outcomes [106]. Similarly, studies could evaluate the impact of initiating exercise at different points relative to surgery or radiotherapy, utilizing adaptive trial designs to optimize intervention delivery based on patient tolerance and treatment phase. Such focused research will provide crucial evidence to guide clinical recommendations for the precise timing of exercise in cancer care.

5.3. Exercise adherence and monitoring methods

The effectiveness of exercise largely depends on patients' adherence, that is, whether they are willing and able to persist in completing the exercise program. To enhance adherence, future research can explore strategies for monitoring and improving adherence based on mobile health technologies, such as using smart watches or smartphone applications to monitor patients' exercise in real-time, and using data feedback and virtual reward mechanisms to motivate patients [107]. Additionally, researching how educational interventions can increase patients' awareness of the importance of exercise, thus intrinsically motivating them, is key to improving adherence [108].

5.4. Interdisciplinary research methods

Cancer rehabilitation is a complex process that involves multiple fields, including medicine, psychology, sports science, and nutrition. Through interdisciplinary collaboration, we can more comprehensively understand the mechanisms of exercise on cancer rehabilitation and develop more integrated intervention programs [109,110]. For example, psychologists can study how to optimize exercise interventions through behavioral change theories, sports scientists can design exercise programs suitable for cancer survivors, and dietitians can provide complementary dietary advice to support patients' exercise plans and physical recovery [27].

In summary, future research on the role of exercise in cancer rehabilitation will be multidimensional, interdisciplinary, and personalized. Through in-depth study of the key areas mentioned above, we will not only better understand the impact of exercise on the psychological health of cancer survivors but also provide more effective, feasible, and comfortable exercise rehabilitation programs, thereby enhancing their quality of life and overall treatment outcomes [111].

5.5. Cultural, demographic and gender considerations

Future research needs to pay more attention to the effects of culture, demographic characteristics (e.g., age, ethnicity, socioeconomic status), and gender differences on exercise intervention effectiveness and adherence. First, cultural values and norms can significantly influence an individual's attitudes and preferences towards sports, as well as the social support systems for participating in sports. For example, some cultures may favor group sports, while others may prefer individualized exercise. Second, cancer survivors of lower socioeconomic status may face barriers to increased physical

participation, such as lack of safe places to exercise, financial burden, and inadequate health literacy [112]. It is important to design low-cost, easy-to-implement exercise interventions for these populations. Furthermore, gender differences are not only reflected in the physiological level (e.g., the influence of hormone levels on exercise response), but also in the influence of social roles and expectations on exercise participation. For example, female cancer survivors may have family responsibilities or body image concerns that affect sports participation. Therefore, future interventions should fully consider these factors and develop culturally sensitive, gender-specific, and socio-economic barriers to improve the coverage and effectiveness of exercise interventions. To comprehensively address these considerations, future studies should not only account for these demographic and cultural variables in participant recruitment but also employ specific metrics to capture their influence on intervention efficacy and adherence. For instance, validated instruments such as the PROMIS® cultural expression tools can be utilized to assess culturally-specific health beliefs and practices [113]. Socioeconomic status can be quantified through established indices (e.g., income, education level, neighborhood deprivation scores), and their impact on access to exercise resources can be explored. Gender-specific assessments, including body image scales (e.g., Body Image Quality of Life Inventory) and questionnaires on perceived social roles, should be integrated to understand their moderating effects on exercise participation and psychological outcomes. By systematically collecting and analyzing these data, researchers can move beyond simply acknowledging these gaps to empirically demonstrating their impact and developing truly tailored interventions.

To inspire real-world adoption, it is also valuable to consider successful examples of exercise program implementation for cancer survivors. For instance, the Livestrong at the YMCA program is a widely recognized initiative that partners with local YMCAs to provide free or low-cost exercise programs tailored for cancer survivors, fostering a supportive community environment [114]. Another notable example is the “Moving Through Cancer” program developed by the American Cancer Society, which offers online resources and connects survivors with local fitness professionals, demonstrating how digital platforms can broaden access to exercise guidance. Furthermore, hospital-based programs collaborating with community fitness centers, such as those seen in many comprehensive cancer centers, successfully integrate exercise into the continuum of care, providing supervised and progressive exercise prescriptions tailored to individual patient needs and recovery stages. These examples highlight the importance of accessibility, tailored approaches, and strong partnerships in ensuring the successful uptake and adherence to exercise interventions among cancer survivors.

5.6. Clinical translation and implementation strategies

Translating research findings into routine clinical practice is paramount for maximizing the benefits of exercise for cancer survivors. Future efforts must focus on developing practical strategies for seamless integration into standard oncology care. The reimbursement models is to establish a clear and sustainable reimbursement pathways for exercise oncology services. This involves advocating for policy changes with insurance providers and healthcare systems to recognize exercise as a

reimbursable component of comprehensive cancer care [115]. Exploring value-based payment models that incentivize positive patient outcomes related to exercise could also accelerate adoption.

Clinician training and education is the provision of adequate training to oncology medical professionals (e.g., oncologists, nurses, physical therapists) on exercise prescription, contraindications, and patient motivation techniques [116]. This could involve integrating exercise oncology into medical school curricula, residency programs, and continuing medical education (CME) courses to build confidence and competence in recommending and referring patients to appropriate exercise programs.

6. Conclusion

Exercise has a significant positive impact on the psychological health of cancer survivors. By improving physiological function, regulating psychological states, and enhancing social interaction and self-efficacy, exercise has become an integral part of comprehensive cancer treatment. Future research should continue to deepen our understanding of the mechanisms of exercise intervention and optimize exercise programs to better serve the recovery process of cancer survivors.

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